

Daily GLOWBUGS

Digest: V1 #130

via AB4EL Web Digests @ SunSITE

Purpose: building and operating vacuum tube-based QRP rigs

[AB4EL Ham Radio Homepage @ SunSITE](#)

%%%%% GlowBugs %%%% GlowBugs %%%% GlowBugs %%%% GlowBugs %%%%

Subject: glowbugs v1 #130
glowbugs **Tuesday, October 7 1997** **Volume 01 : Number 130**

Date: Mon, 6 Oct 1997 09:33:27 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: 24G Hartley?

> Has anyone used the 24G in a Hartley TX? Looks like it would make a good one.

I have. They work just fine! I dropped one in Grandma Hartley with some alligator clippies up to the grid and plate, and she purred just like a kitten, she did.

Bob/NA4G

Date: Mon, 6 Oct 1997 10:02:27 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: Regen Chokes

> I have a few 1 henry chokes of various current capacities. If 1 henry
> works I guess I could use for regen receivers. How about parallel
> resonating the choke at some audio frequency for cw.

Yes, you can do that. It will ring at the audio frequency.

Generically, I prefer to use a 10h power choke, if it is available. But, if one is not, almost anything out of the junk box works. Some work better than others, so try several if you have them handy. I usually use a 0.68ufd coupling cap (got a bunch in a baggie one time) or one of the metal lufd caps that are usually orphans from old hamfest boxes (under the table, etc). A 1 henry choke and a 1 ufd cap should work fine. You might try playing with a cap up to 10ufd even to see if that helps on smaller value chokes.

> How does a 6SN7 dual triode work for a regenerative detector two step.

This is the classic postwar regenerator tube. Works GREAT! Use one as the detector and the first audio. Use the second one as a paralleled triode for the audio output stage. At low voltages you should also be able to use one as the isolating RF stage and detector, and another as the first and second audio stages.

> Have heard some comment about pentodes if properly setup are quite
> sensitive.

Yes, generally they are more sensitive than triodes. But, in my hands two stages of anything are more than satisfactory for generic use.

I ran some tests on my classic regen, using '01A's, '30's, and a '32/30 combo. The 32/30 combo as detector and one step was the most sensitive. But, the pair of 30's was quite close second. The '01A's were about half as sensitive as the pair of 30's, in the same chassis. All combinations were sufficiently good to use as a communications receiver. Another set that uses a pair of '76's was stronger than the '32/'30 set. A pair of 27's in the latter set was the strongest of all. I have not tried a 24/27 pair for comparison.

> What plate voltage would one use on the 6SN7 ?

Traditionally they are run at 45 to 90 volts. I never run homebrew regens at more than 48 volts, and usually opt for 36 volts. It will run quite well at 180 volts, but, I have never had good luck on regens I have built at 180 volts. They become too squirrely at that power. I have always believed that a detector should be operated at the lowest possible voltage for stability in regenerator service. I find that 24 volts makes the best practical minimum with 36 volts a good voltage for maximum gain. At 48 volts things get really hot, but the detector begins to become touchy on the ragged edge of regeneration. For comparison, early Deforest triode detectors operated typically at 18 volts. The RAL and RAK operate at 19-20 volts. They seem to have the design well in hand at that level. The IP-501A line used low voltages also. Technically, you can crank the audio stage as high as you want, up to design limits. But, I usually run zero bias on headphone audio, and keep the plate voltages down to 48 volts or less. If you bias accordingly, then you can jack the audio plate voltages up to whatever you are comfortable with. Myself, I prefer to keep less than 72 volts on any lead to tin cans that sit directly on my head. I almost got zapped one time by a 250 volt line on a pair of tin cans that were less than optimally insulated at the jack on a National AGS-X. I jumped around like a house afire. Once bitten, forever learned. Besides, 36 volts of battery is trivial, these days, with 12 volt sealed lead acid cells common in surplus.

73/ZUT DE NA4G/Bob UP

Date: Mon, 06 Oct 1997 09:02:32 -0500
From: "Robert M. Bratcher Jr." <bratcher@worldnet.att.net>
Subject: Re: 24G Hartley?

At 01:33 PM 10/6/97 +0000, rdkeys@csemail.cropsci.ncsu.edu wrote:
>> Has anyone used the 24G in a Hartley TX? Looks like it would make a good

one.
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>I have. They work just fine! I dropped one in Grandma Hartley with some
>alligator clippies up to the grid and plate, and she purred just like a
>kitten, she did.
>
>Bob/NA4G

Yes I've tried one too. They work just great!
Love playing with older tubes...

bratcher@worldnet.att.net
Record collector, 8mm, super 8, 16 and 35mm Film collector.
Looking for prerecorded reel to reel tape albums.
I like old radio's too.
Collins, Hallicrafters, National & Hammarlund are my Favorites!

Date: Mon, 6 Oct 1997 10:16:27 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: why audio chokes?

>
> Hi Gang
> Guess I mist be stupid or something,
> but cant for the life of me figure out
> why anyone would want to use a choke
> for a det load and coupling in a regen
> when good old rc coupling is so easy.
> I know all the old schematics used them
> or coupling transformers but that was to
> conserve b+ for the plate of the det, when
> using batteries. With a ac power supply I
> see no reason not ot use rc coupling.

Good question.

RC coupling will work at high voltages, but resistor losses in the plate load resistor make it inefficient at low plate voltages below about 90 volts. At 28 volts on the plate, it hardly works at all, compared to choke coupling. If you are content to use 90 volts or more on the plate, then there is no reason why it won't work. I usually run about 24-36 volts on the detector, so use chokes instead.

Bob/NA4G

Date: Mon, 6 Oct 1997 10:28:41 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: More October Regen project

> In my regen I am currently using a grid leak resistor from
> the grid to ground. In other circuits the resistor is in series
> with the tank to grid circuit. I know that the both work but
> was wondering what the advantages of each type, if any, would

> be? Any one have any input?

I am not aware of any particular advantages other than constructional, between the two modes. If you are using a filamentary tube, you probably need to run the resistor to the ground lead. I have used it both ways, across the cap on a traditional set and direct to ground on other sets, and it works fine either way in my hands. Technically, all it needs is a ground leakage path. On older tube bases with less than optimal construction, you don't even need a grid leak resistor, since the socket paths leak enough to properly bias the grid.

Bob/NA4G

Date: Mon, 06 Oct 1997 11:03:38 -0400
From: Todd Nichols <nichols@rtp.ericsson.se>
Subject: Audio transformers - substitutes?

Hey, y'all,

I have been scrounging of late to build a coupla regens and other wondermous BA type thangs. Being caught somewhere between the minimalist approach (embodied in QRP and elegant engineering) and design optimization (being a high-falutin' microwave engineer a la Maxwell's equations), I've been mucking around with scores of articles both on this great list and in old QST's etc, before settling on something to make. I notice that lots of designs have these Thordarsten 3:1 audio transformers for coupling detector to audio sections, and I also notice that Home Depot and Radio Shack do NOT have 'em on the pegboards :-(. Well. Has anyone used any substitutes? Has anyone tried, say, a 24V transformer? I noticed in one CQ column regarding the Globe Trotter RX that folks used to use doorbell transformers (dang, even THOSE are starting to get rarer and more expensive), but I kin git the 24V jobs from RS cheaper than the doorbell xfrm's!

What say ye to that, me buckos?

[I know that the impedance ratio is NOT 3:1, but more like 25:1 due to the 5:1 voltage ratio for 120:24 volts. But has anyone seen it WORK?]

Thanks,
Todd

Date: Mon, 6 Oct 1997 11:25:50 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: October Regen project --- audio chokes

>
> BA Bob,
>
> Thanks for posting all the info on regens. I have been saving them in a
> separate folder on my computer.

I am honored.... you are most welcome. Once upon a time, in a land long ago removed in time..... I started a book on Hartleys and a book on Regens. Someday, if I ever get the time, I will finish them and post them to the group. All the good scoop will be in each volume. The Hartley book is about 3/4 done, and the Regen book about 1/3 done. All I need is time.

> Have you seen KJ7F's web page and the regen schematic there?
> <<http://netnow.micron.net/~kj7f>>

I am bringing it up on another Xwindow..... that is the classic detector and one-step with throttle control of tickler regeneration and impedance audio coupling. At first look, that seems like a straightforward set. There is a little too much capacity, perhaps, IMHO, in the secondary stage (the 100pf cap could be dispensed with and extra coil turns wound on to set the frequency). I would increase the audio coupling cap from 0.01 to a range of 0.5-1.0ufd or so, for starters. It is an audio coupler not an RF coupler. 0.01ufd is pushing the lower audio limits with a 35h coupling choke. Other than that, it looks like a pretty good design for any sort of type '19 through a 12AT7 tube, or a pair of '01A's through 6C4's.

> His is the first diagram for a regen that I have seen that uses a
> capacitor for the regen control (You call it a throttle). Is his circuit
> typical of this arrangement? All the other diagrams I've seen use a pot
> for the regen and I gather that's not the optimum way to go.

The capacitive throttle control of regeneration is the classic and most elegant way of doing the regen control where a tickler is used. The pot method is a cheapskates way of doing it that became popular in the late 1920's when capacitors still cost a weeks wages..... gee they almost still do.....(:+{}..... anymore. Later, in the popular press where the home experimenter was recovering from the depression, a pot was a lot easier to find than a capacitor. Either method works. I, myself, prefer the capacitive throttle control anytime a triode is used. If a pentode or a tetrode is used, then, with proper voltage scaling, a pot control can work quite well.

There are two usual forms of pot control, in triode designs. One is the tickler shunt, where the pot shorts out, effectively, the tickler, to reduce regeneration or becomes effectively high impedance to increase regeneration. The pot is then placed directly across the tickler. This form tends to be scratchy and very touchy to control, requiring a good pot to work well. It can also introduce significant stray capacity and cause body capacity effects as you tune the pot, unless the pot is grounded in the case and floating in the resistance element. The other pot method merely is used as a voltage control to the plate circuit. This mode is not greatly prone to body capacity effects, and is relatively quiet if a capacitance is placed across the pot of about 0.01-0.1 ufd or so.

In pentode designs, the pot control usually adjusts the screen voltage which forms the plate of the triode circuit of the detector. In this mode it works like the triode plate voltage control pot.

> Also, what do you think about using the tank coil from an ARC 5
> transmitter (I know, I don't have the nomenclature correct) for a regen
> set. I thought that the ceramic form and the link coupling might be an
> advantage. I have a couple of junkers laying around (not salvageable,
> sniff.) that I could use.

The ArcusFivus coils would work well, and you have a built-in variocoupler for regeneration or antenna control. You will probably need to rewind the coils since they usually have too few turns to be usable. The 80m coil will work on 40m though, and the 160M coil on 80M with the right capacitive padding, if memory serves me correctly the time I played with it from my junk box parts. What I finally selected was a coil form out of a naval aircraft transmitter that ran on 800 cycles and had the foot cubed plug in tuning drawers (forget the name right off, but I got one before I became a ham, and kept the drawer parts for years and made the coil into my best regen).

> Just kicking around some ideas. Thanks.

This IS the month of regenerator ideas.....(:+}{}.....

> 73.....Steve, WB6TNL

73/ZUT DE NA4G/Bob UP

Date: Mon, 6 Oct 1997 12:18:26 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: Audio transformers - substitutes?

>
> Hey, y'all,
>
> I have been scrounging of late to build a coupla regens and other
> wondermous BA type thangs.....

Sounds like a fine pursuit, to me!

> I notice that lots of designs have
> these Thordarson 3:1 audio transformers for coupling detector to
> audio sections, and I also notice that Home Depot and Radio Shack
> do NOT have 'em on the pegboards :-(. Well. Has anyone used any
> substitutes? Has anyone tried, say, a 24V transformer? I noticed
> in one CQ column regarding the Globe Trotter RX that folks used to
> use doorbell transformers (dang, even THOSE are starting to get
> rarer and more expensive), but I kin git the 24V jobs from RS
> cheaper than the doorbell xfrm's!

There is nothing particularly magical about audio transformers in the generic regen audio mode. Classically they were typified by the 3:1 interstage types. Sometimes they ran as high as 9:1 (the highest I have found). All it has to do is couple the audio from the primary to the secondary at the voltages and currents used. At low voltages, almost anything will work. At higher voltages and currents, it becomes more problematic. There is a very good design article (chapter) in a classic radio amateurs book whose name I forgot right off (must be going senile) (someting like ``Radio Telephony for

Amateurs''), that was printed about 1922. It details how to build them from scratch, what iron to use, what wire to use, what insulation to use, etc. If you can find that, that is your best starting point. I have a xerox of part of that chapter somewhere.....

In my hands, the normal types of filament transformers don't work very well. I have used a 110/220 instrumentation transformer, and that worked pretty well. I would expect that any B+ transformer could be made to work, putting the 110 side as the primary and the B+ side as the secondary. Although, I have not tried the bell transformer, I would expect it to work at lower voltages, but would not want to put more than maybe 36 volts on the 24 volt side as primary. At higher plate voltages, you might begin to push its insulation ratings. I would expect the insulation to be good for 3 times its output rating, but I don't know enough about how those things are made to be sure. Maybe someone who is into transformers could comment for us.

> What say ye to that, me buckos?

Well, try it at lower voltages and do report back.

> [I know that the impedance ratio is NOT 3:1, but more like 25:1
> due to the 5:1 voltage ratio for 120:24 volts. But has anyone
> seen it WORK?]

Well, I have seen impedance transforms of 9:1 used, so my guess is that it should work fine. The only problem is will the 24 volt winding handle the plate voltage rating of your set. In regen coupling use, the primary is the low impedance winding, since the transformers are used as step-up couplers to the grid of the audio stage. In low-voltage battery sets, my expectation is that it will probably work fine.

> Thanks,
> Todd

Good Luck and report back....

Bob/NA4G

Date: Mon, 06 Oct 1997 10:19:41 -0600
From: "Terry L. Dobler" <kj7f@micron.net>
Subject: Re: October Regen project --- audio chokes

At 11:25 AM 10/6/97 -0400, you wrote:

snip

>I am bringing it up on another Xwindow..... that is the classic
>detector and one-step with throttle control of tickler regeneration and
>impedance audio coupling. At first look, that seems like a straightforward
>set. There is a little too much capacity, perhaps, IMHO, in the secondary
>stage (the 100pf cap could be dispensed with and extra coil turns wound on
>to set the frequency). I would increase the audio coupling cap from 0.01
>to a range of 0.5-1.0ufd or so, for starters. It is an audio coupler not
>an RF coupler. 0.01ufd is pushing the lower audio limits with a 35h coupling
>choke. Other than that, it looks like a pretty good design for any sort of
>type '19 through a 12AT7 tube, or a pair of '01A's through 6C4's.
>

```
snip
>
>73/ZUT DE NA4G/Bob UP
>
Bob et al,
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Thanks for the input on my regen. I selected it because it was the classic design. I make no claims of originality, hi. The 100pF capacitor is a left over from the rigs beginning with a pot as the regen control. The throttle capacitor is much nicer. I will try removing the 100 pF cap. The point on the .01 interstage capacitor is well taken and I'll try that also and see what happens. I also plan to reduce the coupling capacitor on the grid of the regen tube and increase the value of the grid leak resistor as per your comments to others to narrow down the bandwidth and see if I like that too. At this point the radio seems to slip into regeneration smoothly and is stable (as long as I keep my hands well away from the L-C tank).

Terry KJ7F

Date: Mon, 06 Oct 1997 12:52:37 -0400
From: Todd Nichols <nichols@rtp.ericsson.se>
Subject: Re: Audio transformers - substitutes?

rdkeys@csemail.cropsci.ncsu.edu wrote:
>
[SNIP]

> At low voltages, almost anything will work. At higher voltages and
> currents, it becomes more problematic. There is a very good design
> article (chapter) in a classic radio amateurs book whose name I forget
> right off (must be going senile) (someting like ``Radio Telephony for
> Amateurs''), that was printed about 1922. It details how to build them
> from scratch, what iron to use, what wire to use, what insulation to
> use, etc. If you can find that, that is your best starting point.
> I have a xerox of part of that chapter somewhere.....
>

This sounds pretty good...I'll check for that pub.

> In my hands, the normal types of filament transformers don't work
> very well. I have used a 110/220 instrumentation transformer, and
> that worked pretty well. I would expect that any B+ transformer
> could be made to work, putting the 110 side as the primary and the
> B+ side as the secondary. Although, I have not tried the bell
> transformer, I would expect it to work at lower voltages, but would
> not want to put more than maybe 36 volts on the 24 volt side as primary.
> At higher plate voltages, you might begin to push its insulation ratings.
> I would expect the insulation to be good for 3 times its output rating,
> but I don't know enough about how those things are made to be sure.
> Maybe someone who is into transformers could comment for us.
>

This is good info. I'll keep on the lookout for instrumentation
transformers. Fortunately, I (mostly) intend to do either the
two-tube Globetrotter/Doerle type stuff or the single-tube

dual triode or triode/pentode combo with batteries, so they will be low-voltage sets.

>
> Well, try it at lower voltages and do report back.
>

The way work is lately, it'll probably take me a couple weeks to get everything scrounged and put together...

...by the way, Bob, I'm the one that stopped by the "Boatanchor Crew" there at Durham this summer, and picked that old klystron out of y'all's' pile (you grammar buffs check that out: dual apostrophes! One for the contraction and one for the possessive :-)

Todd

— — —

-

Date: Mon, 6 Oct 1997 13:04:50 -0400 (EDT)
From: rdkeys@csemail.cropsci.ncsu.edu
Subject: Re: October Regen project --- audio chokes

> At 11:25 AM 10/6/97 -0400, you wrote:
> snip
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> Bob et al,
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> removing the 100 pF cap. The point on the .01 interstage capacitor
> is well taken and I'll try that also and see what happens. I also
> plan to reduce the coupling capacitor on the grid of the regen tube
> and increase the value of the grid leak resistor as per your comments

> to others to narrow down the bandwidth and see if I like that too.

They are only suggestions. The point of this month is to get folks to try things and then report back.....(:+})..... Maybe we will get some new results to ponder and test out. As for originality, it was all original back in the early 1920s! A lot of rehashing has occurred since then, but it is all based on the original ideas from back then. Although the ancient tech is quite fun and enjoyable, it is pretty well cast in stone.

As a rule of thumb, the less the capacitance on the secondary circuit the greater the sensitivity, on input to the detector. It can be quite a difference in sensitivity if the input has 25pf or 125pf on the same set.

Also, on the front end, it can be very beneficial to tune both the primary and the secondary circuits, while maintaining the loosest coupling possible. That will make a big difference in front end selectivity, too.

On the audio coupling. Try a number of different values of coupling cap for YOUR coupling choke, and report back which pair of values of L and C work best for your set. It can vary quite a bit. There is no real optimum value, unless you are trying to resonate the LC for matching the audio to your likes. Even then, there is a fair amount of leeway, and a lot experimentation is possible to get it ``right''. Technocrats might sweep the audio response and plot it out or such. I like to ring it by ear, as long as my ears hold out. When it is done right, you can hear the response peak in the tin cans. You also need to tighten or loosen the tin diaphragms until they resonate altogether at the desired audio peak (most folks forget to do that and the tin cans can resonate hundreds of cycles higher than where you think they are).

> At this point the radio seems to slip into regeneration smoothly
> and is stable (as long as I keep my hands well away from the L-C tank).

That is the mark of a GOOD regenerator. To help reduce body capacity effects, I either put a thin sheet of aluminum behind the panel, or mount the coils and capacitor about 6 inches minimally behind the panel. Use a long insulating coupling shaft to connect to the capacitor, and ground the dial mechanism separately to the chassis ground point. Either method seems to reduce body capacity effects to minimal values.

> Terry KJ7F

Sounds like a nice set so far! Keep us posted.

Bob/NA4G

Date: Mon, 6 Oct 1997 12:52:02 -0500 (EST)
From: "Roberta J. Barmore" <rbarmore@indy.net>
Subject: Re: Audio transformers - substitutes?

On using bell transformers in regens, it's a pretty safe bet that the LV side has got wire insulated at least as well as the primary; enamelled wire is a mass-production item and they don't save anything by trying to buy wire that's not got the usual ratings. (Formvar wire is good for

something like 500VDC, but let's not push it!)

AES sells 3:1 iron for not too much past the point of pain; they also sell just the wound bobbin for half the price, which could be combined with a junkbox core or one from a dead audio for a budget approach.

73,
--Bobbi

Date: Mon, 6 Oct 1997 15:46:56 -0400 (EDT)

From: rdkeys@csemail.cropsci.ncsu.edu

Subject: Re: Hartley Using an 813

> Bob, thank you very, very much for the information. It was just a thought.
> I found I had the old 813 still in its box and thought of the possibility
> of a Hartley style xmtr. I'll start with a small triode and get a little
> experience with it first and then try something bigger.
>
> Thanks, again!
> Best Regards,
> Rod, N5HV
> w5hv@aeneas.net

Sandy/W5TVW had a good suggestion of using the 813 type thing in a Dow circuit ``electron coupled oscillator''. That would also be a very good way to use an 813 as an oscillator. Check J.B. Dow's article in QST back in 1932-1934 (forget the exact reference right off, but I will have it in the Glowbugs archives if I get time to finish the scans and typesetting of the thing). Again, the standard pentode such as the 803 would tend to work better than the beam tube 813, but on 160/80 meters, it might do quite well. Of course, in theme with our Hartley projects, use the Hartley version of Dow's circuit!

Bob/NA4G

Date: Mon, 6 Oct 1997 15:54:13 -0400 (EDT)

From: rdkeys@csemail.cropsci.ncsu.edu

Subject: Regen-Hartley themes.....

You know, folks..... if October is regen month, and November is Hartley month, then December OUGHT to be Glowbugge Etherburning Month!

jus a'thinkin' out'a'loude.....(:+})..... I smell a Globugge function in the makin'.....wassay?

Bob/NA4G

Date: Mon, 6 Oct 1997 22:48:55 -0500 (CDT)

From: Bob Roehrig <broehrig@admin.aurora.edu>

Subject: GC-1 audio compressor results

Well the project the last couple of weeks has been to take the Central Electronics GC-1 compressor and rework it into something usefull. That project is now completed and the results are gratifying. It has been converted to mic input/output levels. With a 30dB input change, the output stays within 4dB. Time constants are fairly fast to respond quickly to voice changes. I also included a soft peak limiter following the compressor circuit to handle any overshoot peaks. Those of you that were interested in this project can send me your addresses so I can mail you the dope.

Having learned (and relearned) some things about compression circuits, I plan to try another circuit from scratch. Part of the success of this circuit was due to using two gain controlled stages. In the next unit, I plan to try three. I have not tried the GC-1 on the air yet but hope to do so soon. Thanks to all that sent me various comments on speech processing.

E-mail broehrig@admin.aurora.edu 73 de Bob, K9EUI
CIS: Data / Telecom Aurora University, Aurora, IL
 630-844-4898 Fax 630-844-5530

Date: Tue, 7 Oct 1997 11:34:51 -0400 (EDT)
From: kim herron <kherron@voyager.net>
Subject: tubes for sale

Hi Gang,

In the process of packing and shipping, I found a box of transmitting tube that I've been hanging onto to play with and realize that it "ain't gonna happen". So I'm going to move them as one lot. here's the list:

4 4D21?4-125's two Eimac, two GE. These were transmitter pulls. Used but good.

1 829B. Jan Ken-Rad. Used, conditon unknown

2 832B's. 1 RCA, 1 National Union. Both with sockets

1 5894. Amperex used, condition unknown

6 416B Western Electric. Looks to be a UHF low power transmitting

2 4X150 Eimac. Used, condition unknown

1 2K28 Raytheon UHF transmitting tube referred to as a "lighthouse" tube.

1 2AP1A Scope tube, complete with socket, and shield

1 3RP1 Scope tube. complete with socket, shield and rubber mounting ring.

1 5BP1 Scope tube. The tube used in a Heath OM-3 5" oscilloscope.

Okay, now that you've made it to the bottom of the list, here's the deal. I'd like \$75.00 for everything with the shipping. I'd rather not split it up. If there are some things that you'd like or need, take the package and

move the things you don't need. Got to clean house here and more stuff will be forthcoming.

Kim Herron
kherron@voyager.net or kherron@vixa.voyager.net
1-616-677-3706

End of glowbugs v1 #130

%%%%% GlowBugs %%%% GlowBugs %%%% GlowBugs %%%% GlowBugs %%%%

[AB4EL Ham Radio Homepage @ SunSITE](#)

Created by **Steve Modena, AB4EL**
Comments and suggestions to **modena@SunSITE.unc.edu**
